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Risk Factors for Childhood Immunization Incompletion in Ethiopia

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ABSTRACT

BACKGROUND: The under-5 mortality rate in Ethiopia is 118/1000. A child in Ethiopia is 30 times more likely to die before age 5 than a child in Western Europe. Children are the most vulnerable segment of the population, but many of the ailments that cause death in this population can be avoided by completion of routine childhood vaccination.

METHODS: Data regarding child health from the Demographic and Health Survey (DHS), a periodic cross-sectional survey administered at the household level was utilized in this study. Data from 8,905 mothers of living children between 0-5 years of age was included in the study. Univariate and multivariate analyses of selected socio-demographic variables were conducted to examine association with vaccination status.

RESULTS: Risk factors for vaccination defaulting were identified. Logistic modeling with the selected factors was conducted with vaccination status and the demographic characteristics of families as independent factors. Type of Residence, Region and Wealth Index were the only significant characteristic in predicting the likelihood of a child being vaccinated when controlled for other factors.

CONCLUSION: The results of this study illustrate that geographic disparities result in lower vaccination completion for lower income families from rural settings than other groups. Families' behavior around child vaccination is a microcosm of various social determinants affecting their decision-making. Resources further removed from health such as better roads and education can improve vaccination uptake.

KEY WORDS: Child Immunization, Vaccination Incompletion, Vaccine Default, Ethiopia

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Acronyms

CDC	Centers for Disease Control
EPI	Expanded Program on Immunization
HEW	Health Extension Worker
GAVI	Global Alliance for Vaccine and Immunization
ICC	Interagency Coordinating Committee
MOH	Ministry of Health
NGO	Nongovernment Agency
RED	Reaching Every District
RI	Routine Immunization
SIA	Supplemental Immunization Activity
WHO	World Health Organization
USAID	United States Agency for International Development

CHAPTER 1: INTRODUCTION

The Eight Millennium Development goals are 1) end poverty and hunger, 2) achieve universal education, 3) promote gender equality, 4) reduce child mortality, 5) improve maternal health, 6) combat HIV/AIDS, malaria, and other diseases, 7) ensure environmental sustainability and 8) develop a global partnership (UN Millennium Project, 2006). These MDGs are health and social outcome objectives that were agreed upon by all UN member nations in 2000 and are to be achieved by 2015. Looking at the fourth MDG, the aim is to reduce the global child mortality rate by two-thirds. More than 10 million of the child deaths each year are caused by lack of application of evidence based, cost effective prevention methods (Black, et al., 2003).Reducing child mortality has positive sequlea such as reduced fertility, which can lead to empowerment of women and can affect performance in the other MDGs. Also, reducing child morbidity ensures that there is a healthy and robust generation contributing to society. Sub-Saharan Africa is the lowest performing region in terms of MDG 4-reducing child mortality.

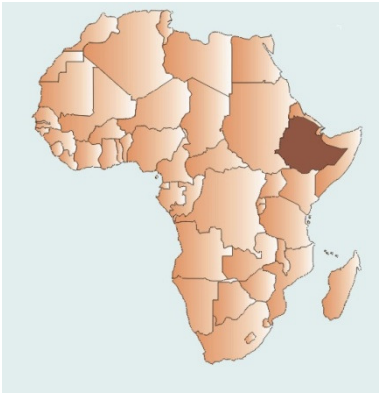

Figure 1. Ethiopia

Ethiopia is one of the lowest performers in all MDGs. The under-5 mortality rate in Ethiopia is 118/1000 (Millennium Development). In fact, a child in Ethiopia is 30 times more likely to die before age 5 than a child in Western Europe (Millennium Development). Children

are the most vulnerable segment of the population, but

many of the ailments that cause death in this population can be avoided by completion of routine childhood vaccination. Since the 1960s, prevention methods such as childhood vaccination are the main reason for improvements in child survival in developed world (Callreus, 2010). The global Universal Childhood Immunization initiative goals for Routine Immunization (RI) is 80% coverage (Immunization). Ethiopia, currently has an aggregated coverage rate of 61-75%, well below the international standard (WHO:Expanded program on immunization). Figure 2 illustrates Ethiopia's performance in relation to other countries. Within Ethiopia, regional coverage ranges from 4-92% (WHO: Expanded program on immunization).

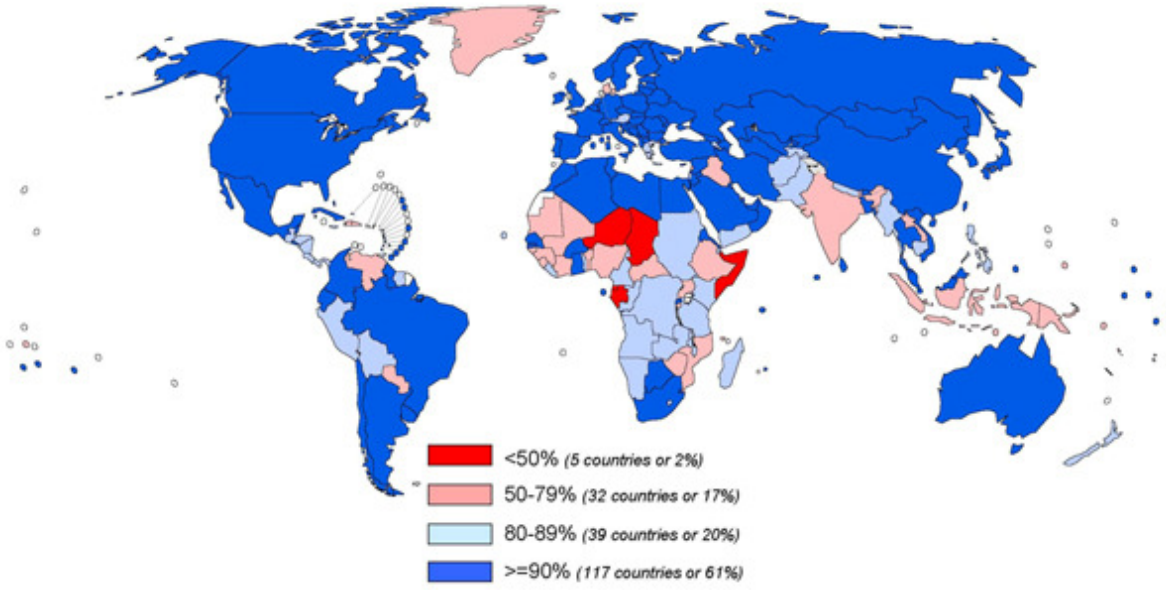

Figure 2. Global Coverage of DPT3 vaccination, 2007

Source: Ducloset al.(2009). *BMC International Health and Human Rights*.**9**(Suppl 1):S2

Risk factors for not receiving childhood Immunization may be a combination of push and pull factors. Both ministry of health efforts to immunize children (push) and

parents demand for their children's vaccination (pull) are needed to make RI and Supplemental Immunization (SI) successful. In Ethiopia as in many developing countries, international organizations, such as the World Health Organization (WHO), and The Global Alliance for Vaccine and Immunization (GAVI), and bilateral partners such as United States Agency for International Development (USAID), Centers for Disease Control (CDC) play an important role in the success of immunization efforts. Location of healthcare facilities; ratio of healthcare worker to patient; and seamlessness of nongovernmental organization (NGO) efforts with ministry of health(MOH) efforts, can play a role in the supply of vaccines. At the same time, community education efforts and vaccine promotion campaigns can also affect the demand for childhood vaccines among parents and caregivers (Shea, Andersson & Henry, 2009). Previous studies have demonstrated that behavior and characteristics of parents and caregivers can give an indication of a child's likelihood of being vaccinated (Sullivan et al., 2009; Tadessa, Deribew & Woldie, 2008 Vandermeulen et al., 2008; Andersson, et al., 2009).

1.1 Study Objectives & Research Questions

RI default, failure to complete the recommended schedule, occurs in both developed and developing countries (Vandermeulen et al., 2008; Luman et al., 2003; Andersson, et al., 2009). The purpose of this study is to further examine characteristics of parents and caregivers that may influence vaccination defaulting in Ethiopia. More specifically, this thesis will address the following questions:

1. What are some characteristics of parents and caregivers associated

with no and incomplete child vaccination in Ethiopia?

2. Is the group with high vaccination and the group with low vaccination significantly different from each other?
3. Are there any identifiable differences between rates of children who have not received any vaccinations and those that have received some, but incomplete vaccination?

It is hoped that that the results will improve policies and health promotion efforts around childhood vaccination uptake and serve as a tool for increasing utilization of existing Expanded Program on Immunization (EPI) efforts that will allow Ethiopia to achieve MDG 4.

CHAPTER 2: REVIEW OF LITERATURE

A review of literature suggests that vaccination defaulting occurs in many types of settings and that socio-demographic characteristics of the general population, caretakers, cultural factors and accessibility of services influence uptake of childhood immunization.

2.1 Population Structure & Morbidity

The population of Ethiopia was estimated at 83 million in 2007(Human Development Report, 2009). Life expectancy at birth is about 54 years for women and 51 years for men (United Nations Statistics Division). According to the *State of the World's Children*, a report on child outcome indicators compiled by the United Nations Child Fund (UNICEF), the infant mortality rate in Ethiopia in 2007 was 75/1000 (UNICEF). Infant mortality rate is the probability of dying between birth and one year of age. According to the same report, the under-5 mortality rate in Ethiopia was 118/1000 in 2007. However, regional variations in child mortality are not captured by these aggregates. The population is fairly young with 0-14 year old making up 43% of the population (United Nations Statistics Division). The Ethiopia Demographic and Health Survey (EDHS) estimated this proportion to be 48% of population. This is a predominant feature of populations with high fertility rates and low life expectancy (Ethiopia Demographic and Health Survey (EDHS), 2005).

These population statistics may give an indication of social norms of fertility and child

rearing. Parents' expectations of child mortality can lead to high fertility (Fitaw, Berhane, Worku, 2004). As the number of children in a household grows, parents' time and other resources must be shared among more children. This can decrease the quality of care each child receives, including RI, which can play a role in child morbidity and mortality. Additionally, high fertility can have negative effects on maternal health outcome (Bour & Bream, 2004).

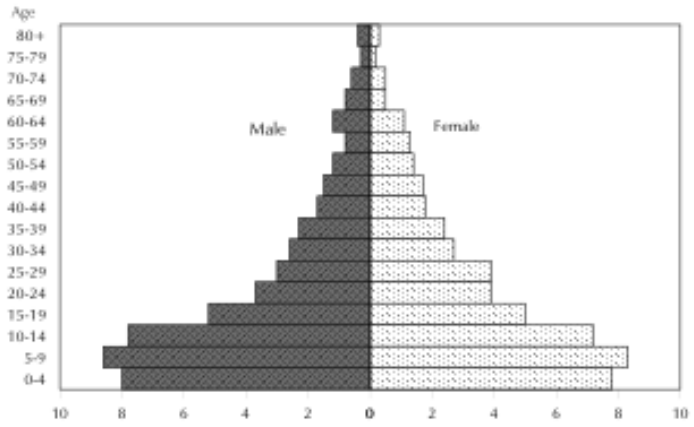

Figure 3. Ethiopia Population Pyramid (Ethiopia Demographic and Health Survey, 2005)

Countless incidences of severe morbidity from childhood illnesses are not captured in data. Incomplete immunization has been the main cause of several outbreaks of vaccine preventable diseases in Ethiopia. Childhood Immunization, completed by age 12 months, provide immunity against tuberculosis, poliomyelitis, tetanus, diphtheria, pertussis, and measles (Kidane, 2006). Childhood immunization coverage is fairly low in Ethiopia. Only 20% of the population was immunized against measles, a leading cause of child mortality (Human Development Report, 2009).

2.2 Geography & Governance

The diversity of the population, geography and their lifestyle plays a role in child immunization. Ethiopia has a federal governance system. The nine regional states and two chartered cities of Ethiopia are divided based on cultural and linguistic lines. The nine regional states consist of Afar, Benishangul-Gumuz, Gambella, Harari, Oromiya, Somali, the Southern Nationals, Nationalities and Peoples Regional State (SNNP) and Tigray. The two administrative cities are Dire Dawa and the capital, Addis Abeba (also Addis Ababa). This system was established in the 1994 constitution and was instituted as a means for providing the right of self-governance to identity groups, thus furthering democratic governance (United Nations Statistics Division). Religion, food, livelihood and other cultural practices vary from region to region.

The Great Rift valley, which is caused by two divergent plates, runs across Ethiopia. This geologic feature also creates varied topography with 116m (381 ft) below sea level in the Afar Depression to 4,620m (15,157 ft) above sea level in Ras Dashen Mountain in Tigray. Child immunization providers in Ethiopia have the burden of reaching very diverse populations. Culture of the population at each elevation is shaped by the geography. Different types of food is grown and consumed at each elevation and nutrition status of children also varies due to geography and issues of access. Iodine deficiency is prevalent in the mountainous areas and Vitamin A deficiency is an issue in Amhara and Tigray (Kaluski, Ophir & Amede, 2002). Vitamin A deficiency is a risk factor for acquiring measles, a vaccine preventable disease contributing to child mortality in Ethiopia (Yang, et al., 2005). Depending on the

elevation and location, the availability of clean water may vary. Lack of clean water can lead to diarrhea in infants and loss of efficacy in vaccines administered orally.

Ethiopia lies at the equator and has seasonal monsoons. Poor roads are made more hazardous during this time, which has implications for both transportation of vaccines from the capital to peripheral areas and parents ability to travel to immunization sites. Pastoralists who travel seasonally live in Afar and Somali regions. Nomadic people must be reached in a different way than sedentary populations.

2.3 Income & Education

A number of economic characteristics of families affect the underlying tendency to default on childhood immunization. Ethiopia ranked 171th out of 182 in the United Nations Development report's Human Development Report (2005), a ranking of various social and economical factors that affect life chances (Human Development Report, 2009). The Human Development Report gives an indication of Ethiopia's standing in the world stage and some indication for the economic wellbeing and standard of living in Ethiopia, which may affect decisions around childhood vaccination uptake. Economically, the cost-benefit analysis at the household level may deter parents from demanding child immunization. For parents and caregivers, the present cost of vaccination may surmount the possible cost of future illness (Andersson, et al., 2009). Family income has been seen to be a significant predictor of vaccination defaulting (Shea et al., 2009). Additionally, education, which is closely related to income and other means of social capital is also a factor that influences

vaccination uptake. According to the Human Development Report, adult literacy is about 42% in Ethiopia (2005). The male adult literacy rate is 50% and 35% for females. Analysis of DHS data from 22 countries have shown that maternal education is significantly associated with child immunization (Sullivan, et al., 2009). Studies have also seen a similar link with paternal education (Vandermeulen, et al., 2008; Reading, Surridge & Adamson, 2004).

2.4 Ethiopia Health Administration

The doctor to patient ratio in Ethiopia is approximately 1:118,000. The nurse to patient ratio is 1:9,000 (Berhane, 2008). The Health Sector Development Program (HSDP) was launched in 1998 to restructure and strengthen the healthcare system of Ethiopia. This program was specifically designed to address the needs of rural populations and focused on primary healthcare needs (Kaluski, Ophir & Amede, 2002). The health system in Ethiopia consists of four levels of services: specialized hospitals, general hospitals, health centers, and health posts. Health posts are the lowest level of healthcare and are staffed by two health extension workers. The extension workers have one year vocational training with continuing education during their service (Kaluski, Ophir&Amede, 2002). The Interagency Coordination Committee (ICC) advises the Ministry of Health and is working in regions with low immunization rates. The ICC consists of Save the Children-USA, Medecins Sans Frontieres-Belgium, Ethiopian Red Cross, Save the Children-UK, Mother and Child Development Organization, United Nations Children's Fund (UNICEF) and WHO (Kidane, 2006).

2.5 EPI in Ethiopia

The Ethiopia EPI was started in 1980 with an intention of reaching 100% coverage by 1990 (WHO: Expanded program on immunization). The EPI program in Ethiopia is administered by the Ministry of Health with technical support from the WHO and other organizations (Sullivan et al., 2009). International partners provide extra support in expanding coverage of EPI. For instance, the Reaching Every District (RED) approach is a collaboration with the WHO, USAID, UNICEF, Global Alliance for Vaccines and Immunization (GAVI), and Centers for Disease Control (CDC) (Kidane, 2006). The RED approach consists of strengthening social mobilization activities, and developing culturally appropriate behavioral change communication strategies (Berhane, Y, 2008).

The EPI schedule for RI in 2005 consisted of nine rounds of vaccinations to be completed by the child's first birthday.

Table 1. Schedule of EPI Routine Immunization

Vaccine	Disease	Age
BCG	Tuberculosis	At Birth
DPT	Diptheria, Pertussis, Tetanus	6, 10, 14 Weeks
OPV	Polio	At Birth, 6, 10, 14 Weeks
Measles	Measles	9 Months

Studies have shown inconclusive results of the necessity for birth dose of oral polio vaccine (OPV) (Benn et al., 2008). However, it is recommended for added protection in regions with high poliovirus prevalence. Women of child bearing age receive tetanus toxoid vaccine to protect their unborn children. In 2007, the EPI schedule for developing countries was updated to include a pentavelent consisting of the tetravalent of DPT and Hepatitis B and Haemophilus Influenza type B (HIB).

2.6 State of Immunization according to the 2005 Ethiopia Demographic Survey

Demographic and Health Survey (DHS) conducted with nationally representative cluster samples periodically. This cross-sectional data was first collected in Ethiopia in 2000 and then subsequently in 2005 and 2010. The following are trends found in the 2005 Ethiopia Demographic and Health Survey (EDHS) data. Twenty percent of children age 12-23 months had been fully vaccinated at the time of the 2005 survey. Three in five have received the BCG vaccination, and 35 percent have been vaccinated against measles. The coverage for the first dose of DPT is relatively high (58 percent). However, only 32 percent go on to receive the third dose of DPT. Polio coverage is much higher than DPT. However, the dropout between the first and subsequent doses of polio vaccine represents 40 percent decline (between the first and third dose). Vaccination coverage in Ethiopia has improved over the past five years. The percentage of children 12-23 months fully vaccinated at the time of the survey increased from 14 percent in 2000 to 20 percent in 2005. According to the DHS survey, only one in three women was protected against neonatal tetanus (EDHS, 2005).The EDHS shows lower coverage than the health administrative data due to differences in sampling weights of data (Kidane, 2006).

2.7 Access

Parental self-efficacy around child immunization is affected by structural access to health facilities. A national survey of defaulters in Ethiopia showed that *kebeles* (districts) with Health Extension Workers (HEW) were more likely to have higher coverage. Also, kebeles where the immunization sites were within 1 hour of walking

distance had higher coverage than those with longer walking time (Kidane, 2006). Mothers, who can receive continuity of care after childbirth through a health facility, may seek immunization for their child. Mothers who used post-natal health services were more likely to complete vaccination (Tadessa et al., 2008; Sullivan et al., 2009). Knowledge about vaccination is attained through various channels including interaction with healthcare centers. Mothers and caretakers who did not know the schedule of vaccines and the benefits of immunization were 6 times more likely to have defaulter children (Tadessa et al., 2008; Sullivan et. al., Kidane et al., 2006). However, parents' decision to immunize their child is also affected by perceived efficacy of vaccination. In rural communities, one family's negative experience can affect the decisions of other families in the community. According to a review of EPI in Ethiopia, in addition to high drop-out rates, inadequate number of health workers and inadequate supplies such as cold chain storage to keep vaccinations effective affect the efficacy of the EPI program(Kidane, 2006). Interpersonal communication between community members and spousal communication has lead to diffusion of modern health practices (Valente & Saba, 2008). Since, the positive effect of interpersonal communication can be strong, it can also have a negative effect of keeping families from taking up beneficial health practices. This form of communication may further exacerbate the effects of healthcare access by compelling families to have negative attitudes towards immunization or perceiving it as an extra burden rather than a normalizing it as part of life.

RI coverage varies in Ethiopia by regional states. Regional differences in vaccine coverage varies from 10% in the state of Somali to over 80% in the state of Tigray

(Kidane, et al., 2006). Vaccination coverage of children was significantly higher in urban areas than rural areas (Kidane, et al., 2006). The under-five mortality in the capital of Addis Abeba is 72/1000 while the rate is 157/1000 in the state of Benishangul-Gumuz (EDHS, 2005).Coverage is low in Somali, Gambella and Afar(Kidane, et al., 2006). Pastoralist lifestyle of the people in Afar and Somali create an added constrain in providing access to healthcare in these regions. Pastoralists have different needs from sedentary rural communities. Health posts located in one area might be inaccessible for communities two or three years later. EPI is supported by international monetary and technical aid. International NGO partnerships can help curb some of the constrains by aiding better planning (WHO:Expanded program on immunization).

2.8 Social Capital

Reasons for routine vaccination noncompliance have been studied both in Ethiopia and other countries, and many of the reasons have correlations with proxy measures of social capital. Father's ability to speak English was found to be significantly associated with uptake of child vaccination in Ghana (Burgha et al., cited in Sullivan et al., 2009). Sullivan et al., found that higher paternal age correlated to greater likelihood of vaccination completion (2009). Decision making power of women is also associated with childhood vaccination (Fantahun et al., 2006). One aspect of social capital, male gender of child is seen to have a better effect on child outcome in many developing countries. In Ethiopia, this is not the case. Male infant mortality in Ethiopia is higher than the female infant mortality (Gmariam, A, 2005; EDHS, 2005). According to Kidane, age of mother, and sex of child were not significant factors in vaccination

uptake (2006). A study of child immunization uptake in the UK found that children in larger families were more likely to have incomplete immunization (Reading, Surridge and Adamson, 2004). Children of low parity households in Ethiopia were also more likely to be vaccinated than those in high parity families (Kidane, 2006). Tadessa et al., did not find that family size, age of mother, ethnicity, religion or educational status were associated with defaulting in their study in Southern Ethiopia (2008). However, this trend may not be generalizable to the whole country.

2.9 Decision-making in Relation to Health

Mothers and caretakers with a negative perception towards health institutions were 2 times more likely to have children who default from vaccines (Tadessa et al., 2008). In addition to factors such as distance and access, social interactions between parents and health workers may play a role in uptake of vaccines. Health workers with little experience may lack the ability to identify mothers' at risk of defaulting and provide the extra attention needed to encourage them to return for the next RI visit. Demands on the health workers' time may also affect their ability to provide this counseling. Studies on childhood vaccination defaulters in Turkey and Bangladesh showed that paternal attitudes towards vaccination was a significant factor in vaccination completion (Torun &Bakirci, 2006; Chowdhury et al., 2003). Additionally, traditional health remedies are still used for ailments in many regions and this viable option may affect decision making around vaccination.

2.10 Politics

During conflicts, health infrastructures are not maintained and priority is taken away from preventive measures such as child immunization. A study of vaccination coverage in Freetown, Sierra Leone uncovered that during conflict routine immunization rates reduced by 50% and delayed and incomplete immunization created a higher risk of children acquiring vaccine preventable diseases (Senessie et al., 2007). Ethiopia has experienced civil conflict for a number of years. Until 2000, much of Ethiopia's resources were spent in the border conflict with Eretria. Ethiopia is bordered by Sudan to the north and Somalia to the East, countries currently in conflict. Ethiopia houses refugees from these conflict areas within its borders. Along with the migration of refugees from these conflict zones, diseases have also crossed borders. Both Sudan and Somalia have had protracted conflict and cases of preventive child illnesses such as polio have been imported into Ethiopia from these areas (Mesfin et al., 2008). Differentials in vaccination levels between countries with porous borders can cause outbreaks in vaccine preventable diseases. This situation can be further exacerbated if children within a country have incomplete immunization.

2.11 Epidemiology of Vaccines

Incomplete immunization can put children at greater risk of acquiring an ailment. Vaccine efficacy is affected by child's nutrition status. The types of vaccines used in the developed and developing world are different. Risk levels of various diseases are different in developing countries and developed countries. Additionally, vaccinations are developed based on etiology of viruses and with consideration towards preventing

logistical hurdles to efficacy. For instance, oral polio vaccine is used in many developing countries including Ethiopia due to their ease of use. OPV consists of live attenuated vaccines and is administered as oral drops. This is easy to administer by health workers with all levels of training. However, diarrhea is a problem among infants in Ethiopia and a child suffering from diarrhea may purge the vaccine and not develop immunity. Injectible polio vaccine (IPV), used in many developed countries consists of dead poliovirus strains and mitigates the effect of diarrhea. However, IPV requires a higher level of training for the health worker administering the vaccine and can pose a higher threat for children who do not complete all three vaccination dosage. Similarly, different pertussis vaccines are used in developed and developing countries due to perceived risk (Jadhav, Gautam, Gairola, 2009). Higher cost acellular vaccination is used in the US and many developed countries due to lower perceived risk while a vaccination from the whole cell is used in developing countries. In addition to science, varied real world issues to ensure effectiveness and efficacy of vaccination also have to be considered.

Problems with cold chain storage of vaccines is a problem in rural parts of Ethiopia (Kidane et al, 2009). Therefore, the vaccine reaching remote rural areas may not have same efficacy as those available in the capital, Addis Abeba and other urban areas. In one study 21% of Ethiopian measles vaccinations administered were in fact ineffective (Kidane, et al., 2006). Community members' experiences with vaccines can affect family's perception of vaccine efficacy. Family decisions around vaccination seeking is affected by perceived efficacy of vaccines. Given geographic disparity in travel and time cost of vaccination, vaccination efficacy plays a role in vaccination seeking. Some

vaccines obtained after the age 12 month window recommended by EPI are still effective, policies and recommendation that allow catch-up, when children have defaulted, are needed for Ethiopia where the dropout rate is very high.

CHAPTER 3: DATA AND METHODOLOGY

3.1 Data Source

The Demographic and Health Survey (DHS) is a periodic cross-sectional survey administered at the household level, funded by USAID in many middle and low income countries. The first Ethiopia DHS (EDHS) was conducted in 2000 and then subsequently in 2005 and 2010. For this analysis, data from the 2005 Ethiopia DHS, is being used. Data from the most recent (2010) EDHS is not available to the public. In addition to the USAID, the EDHS is funded by several other international partners and the Ethiopian Ministry of Health.

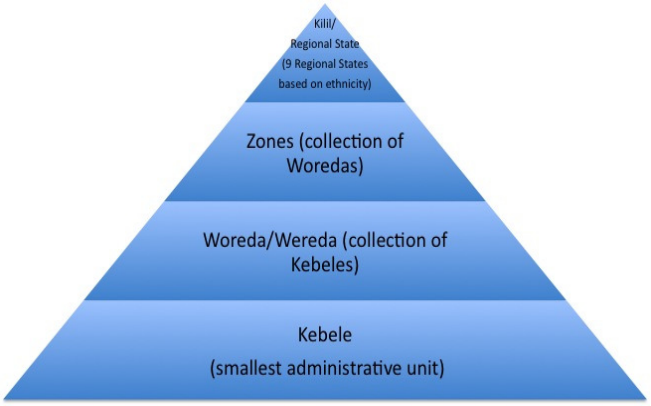

Figure 4: Ethiopia Administrative Divisions

The nationally representative EDHS 2005 data was collected under the guidance of the Central Statistical Agency of Ethiopia. Interviews were conducted with 14,070 women and 6,033 men and the women's questionnaire included sections that covered child health, nutrition, family planning practices, women's empowerment, and HIV/AIDS related knowledge among others(EDHS, 2005).

These data utilize a cluster sampling method with the interviewer collecting data face-to-face. The 2005 Ethiopia DHS consisted of a nationally representative sample of approximately 14,500 households from 540 clusters. The sample was selected in two

stages. In the first stage, 540 clusters (145 urban and 395 rural) were selected from the list of enumeration areas (EA). This EA is similar to a census tract used by the US Census. In the census frame, EAs are developed at the Woreda level (see Figure 3). Each EA was either totally urban or rural and the EAs were grouped by administrative Woreda (EDHS, 2005). The implementers of the DHS mention that there may be some under-representation of nomadic people in Somali and Afar in the sample frame. Since the 540 EAs selected for the EDHS are not distributed by region proportionally to the census population, the sample for the 2005 Ethiopia DHS had to be weighted to produce national estimates. As part of the second stage, a complete household listing was carried out in each selected cluster. Between 24 and 32 households from each cluster were then systematically selected for participation in the survey. DHS have been conducted in many countries. However, the standard questionnaires require cultural adaptation and language translation. The Ethiopia DHS was adapted and validated by a team of experts consisting of Ethiopian medical experts and demographers. Improved methodological and logistical planning made the 2005 EDHS an improvement over the previous EDHS. The questionnaires were translated to the three predominant languages in the country: Amaharic, Tigrigna and Oromiffa. The DHS consists of the Women's Questionnaire and the Men's Questionnaire. The DHS was pretested in all three languages in both urban and rural areas. In Ethiopia, the women's questionnaire was administered at each of the households and information was collected on each woman age 15-49. The Men's questionnaire was administered at every other house visited. The data were collected through face-to-face interviews with same gender interviewers. The survey data were coded by two different data

entry workers. DHS tends to oversample for households with younger children given the health vulnerabilities of this population (Kaluski, Ophir &Amede, 2002). The sample for the complete 2005 EDHS survey was 13,721 households. However, for this analysis, only one portion of the EDHS data pertaining to maternal and child health is analyzed. The sample used in this data consists of 9,861 female respondents. Of these respondents, 9,517 of them had children age 0-5. Due to missing data, for analysis of vaccination, 8,905 children age 0-5 years of age are captured by the data with the questions being answered by their mothers. Response rate was higher in rural settings than urban settings.

3.2 Variables

Dependent Variables

For this analysis, Selected variables from the EDHS 2005 data was analyzed with SPSS 17.0 (Statistical Package for Social Sciences). Some data was recoded in SPSS 17 to allow for analysis.

The Ethiopia Expanded Program on Immunization (EPI) provided Bacillus Calmette Guerin (BCG) vaccination, 3 rounds of Diptheria, Pertussis, Tetanus (DPT) vaccination, 3 rounds of Oral Polio Vaccination (OPV) and Measles during the first year of a child's life in 2005. BCG was the first routine vaccination given up to 1 week after birth and measles was usually the last vaccine given at 9 months after birth. Table 1 provides the full schedule for routine immunization. The DHS women's questionnaire asks the status for each of the 9 EPI vaccines as well as Vitamin A drops. The survey allows the following options for answers to these questions:

-No — denoting child has not received vaccination;

-Yes — denoting vaccination record is complete;

-Vaccination is reported by mother, but interviewer has not seen vaccine card;

-Vaccination receipt is marked on card, but the dates and other information are not complete;

-Don't know—denoting the mother does not know whether the child has received vaccination and there is no card. For this analysis the answers to these questions were collapsed into dichotomous answers. No and Don't Know were coded as No, for the purpose of this study, denoting child has not received vaccination. Yes, Vaccination reported by mother, and Vaccination reception marked on card were coded as Yes. Some scholars worry about mothers' recall bias, others found that parental recall is similar to measured counts (Goldstein, et al., 1993; Langsten& Hill, 1998; Mitchell, et al., 2009).

This data analysis explored age appropriate timely immunization adhering to EPI schedule. The counts of these vaccines were then summed to create an outcome variable with three categories: no vaccination, partial vaccination and complete vaccination. Vaccination data was missing for a number of children ages 0-5 years. These may represent errors in data collection or enumeration. Vaccination information was coded for 8,905 children. Summation included all EPI vaccines except for OPV 0 (oral polio vaccine given at birth), since literature review showed that this vaccine is recommended, but not necessary to developing immunity to the poliovirus. The three category vaccination completion dependent variable was dichotomized for logistic modeling consisting of No/Partial and Complete.

Independent Variables

Several variables from the data were used independent as independent factors in these analyses.

Data are coded for geographic location of residents allowing analysis based on residence in the nine regional states and two administrative cities of Ethiopia. Data is also coded for rural and urban residence.

The variable wealth index in the EDHS was constructed using household asset data including ownership of a number of consumer items ranging from television to bicycle or car, as well as dwelling characteristics, such as source of drinking water, sanitation facilities and type of material used for flooring (EDHS, 2005). This variable is presented in quintiles: poorest, poorer, middle, richer, richest.

Respondents are surveyed on their and their partner's highest education attained. Respondents' education and partners' education is presented in 4 strata: none, primary, secondary, higher. Respondents' age range is presented in 7 strata consisting of 4 years, ranging 15-49. Partner's age is available as continuous from 15-99. Some independent variables were recoded to allow proper analysis in SPSS. For the purpose of this analysis, partner's age variable was recoded to have similar age ranges as women. The last category contained all ages greater than 45. Data exploration uncovered the oldest partner to be 99 years of age. Due to smaller frequencies at older age values, these numbers were collapsed. The women were sometimes unaware of their partner's education level and their age. These responses are coded as "Don't

Know." For the purpose of these analyses, "Don't Know" for these two variables were recoded as missing and excluded from further analyses.

Parity had been uncovered as an important risk factor for child immunization default in literature. The child's "birth order" variable allowed the possibility of exploring each child's risk factor in terms of mother's parity. Birth order was a continuous variable ranging 1-16. The frequency of birth order dropped sharply at seventh child. This variable was collapsed into seven categories: each category containing one birth order up to 6^{th} , with 7^{th} and more as the last category to include all others.

During logistic modeling, several variables were reordered to allow the referent to be the first or last category. Reference category was chosen based on the previous analysis results of probability model of least risky group.

Other Variables

All 9,861 women in the survey had at least one birth in the last 5 years. This was uncovered in the variable "births in the last 5 years." In examining the participants of the survey further, the variable "number of children 5 and under" was explored. This variable includes only those children in the household at the time of survey. Mothers were asked how many children age 0-5 they had. The counts of number of children ranged from 0 to 5 children.

3.3 Data Analyses

Chi-square analysis was conducted to examine associations of vaccination status with various characteristics identified as risk factors during the literature review. The

variables explored include: birth order, type of residence, region, wealth index, mother's education, father's education, mother's age and father's age.

Multivariate analysis was then conducted to further analyze these risk factors. The regressions were binary, where the dependent variable was dichotomized into: no/partial vaccination and complete vaccination. The variable was dichotomized in this way because literature review had uncovered that no vaccination and partial vaccination pose similar threat to acquiring disease. Logistic regression analysis was conducted with SPSS 17.

RESULTS: CHAPTER 4

4.1 Study Population

The total sample of women from the EDHS data is 9,861. The distribution of various demographic characteristics among this sample is shown in Table 2. Birth order ranged from 1 to 16 and the majority of the children in this sample were the first born child (19.4%). However, due to smaller numbers and the spread of the variable, the range of birth order was collapsed. A significant number of respondents (86.2%) were rural residents. This distribution corresponds to the type of residence among the general population in Ethiopia. In terms of the wealth index, the sample consisted of the richest 20% of the population and the poorest 25% of the population with 17-19% at other levels in between. Mother's age ranged from15 to 49. However, the majority of mothers (28%) were in the 25-30 age range. Based on mother's knowledge on their child's father's education and age showed that most of the fathers were in the age range of 30-34 (20%) and the majority had no formal education (59%). . In some cases, the mothers were not able to answer this information for their partners. As the distribution shows, father's education level was not known by the mother in 1.1% of the cases and father's age was not known for 6.5% of the cases. Of note, 19% of respondents were in a second union at the time of survey and although the term "father" will be used to describe mother's partner, this may not correspond to biological paternity of child

Table 2: Demographic Characteristics of Ethiopia DHS Respondents (N=9861)

Characteristics	Frequency	Percentage
Birth Order		
First Child	1917	19.4
Second Child	1640	16.6
Third Child	1433	14.5
Fourth Child	1239	12.6
Fifth Child	1012	10.3
Sixth Child	845	8.6
Seventh & Above	1775	18
Residence		
Rural	8503	86.2
Urban	1358	13.8
Region		
Tigray	980	9.9
Afar	574	5.8
Amhara	1458	14.8
Oromiya	1938	19.7
Somali	663	6.7
Ben-Gumz	698	7.1
SNNP	1730	17.5
Gambela	515	5.2
Harari	514	5.2
Addis Abeba	380	3.9
Dire Dawa	411	4.2
Wealth Index		
Poorest	2529	25.6
Poorer	1846	18.7
Middle	1837	18.6
Richer	1672	17
Richest	1977	20
Mother's Education		
None	7609	77.2
Primary	1548	15.7
Secondary	633	6.4
Higher	71	0.7

Characteristics	Frequency	Percentage
Father's Education		
None	5834	59.2
Primary	2538	25.7
Secondary	1191	12.1
Higher	194	2
Don't Know/Missing	104	1.1
Mother's Age		
15-19	533	5.4
20-24	2062	20.9
25-29	2845	28.9
30-34	1992	20.2
35-39	1499	15.2
40-44	644	6.5
45-49	286	2.9
Father's Age		
15-19	18	0.2
20-24	440	4.5
25-29	1456	14.8
30-34	1964	19.9
35-39	1843	18.7
40-44	1376	14
45+	2123	21.5
Don't Know/Missing	641	6.5

4.2 Wealth

Further analysis of the wealth index was conducted to explore the distribution of this characteristic among the sample. The distribution of wealth by region shows some skewedness and may reflect the proportion of distribution in the general population. For instance, 458 (69%) of the 663 women sampled in the Somali region were in the lowest wealth quintile. At the same time, 358 (94%) of the 380 sampled in the capital, Addis Abeba were from the highest wealth quintile. Wealth is measured in

terms of a basket of consumer goods and measures of development such as such as sanitation and source of drinking water.

Table 3. Wealth Distribution by Region

	Poorest	Poorer	Middle	Richer	Richest
Tigray (N=980)	36%	26%	20%	11%	8%
Afar (N=574)	73%	9%	6%	4%	7%
Amhara (N=1458)	18%	20%	24%	24%	13%
Oromiya (N=1938)	22%	24%	22%	19%	13%
Somali (N=663)	69%	11%	6%	5%	10%
Ben-Gumz (N=698)	18%	24%	24%	18%	15%
SNNP (N=1730)	10%	19%	26%	26%	19%
Gambela (N=515)	38%	17%	7%	18%	20%
Harari (N=514)	7%	10%	16%	21%	46%
Addis Abeba (N=380)	1%	2%	2%	1%	94%
Dire Dawa (N=411)	17%	15%	10%	5%	52%

4.3 Children's Profile

At the time of survey, of the initial 9,861 respondents, 9,517 women had children between 0-5 years of age in the household. All 9,861 women in the sample had given birth in the last 5 years. However, 344 (3.5%) answered that they did not have a child age 5 or under. This difference may be due to mortality or various reasons a child may not be living with the mother. Of the 9,517 children, vaccination information was only available for 8,905 children and their mothers representing a completion rate of 93%. Vaccination status of these 8905 children is shown Table 4.

Table 4. Vaccination Status

Vaccination Status (N=8905)		
	Frequency	Percentage
No Vaccines	2984	29.3
Partial Vaccination	4651	47.2
Completed EPI Vaccinations	1360	13.8

Of the 9,517 women with children up to five years of age, 3,426 (36%) of the

children were the mother's only child under five years of age; 4,568 (48%) were one of two children under five; 1,369 (14%) were one of three children under five; 133 (1%) were one of 4 children under the age five; and 21 (0.2%) were one of five children under the age of five. Figure 4 shows the number of children under five years.

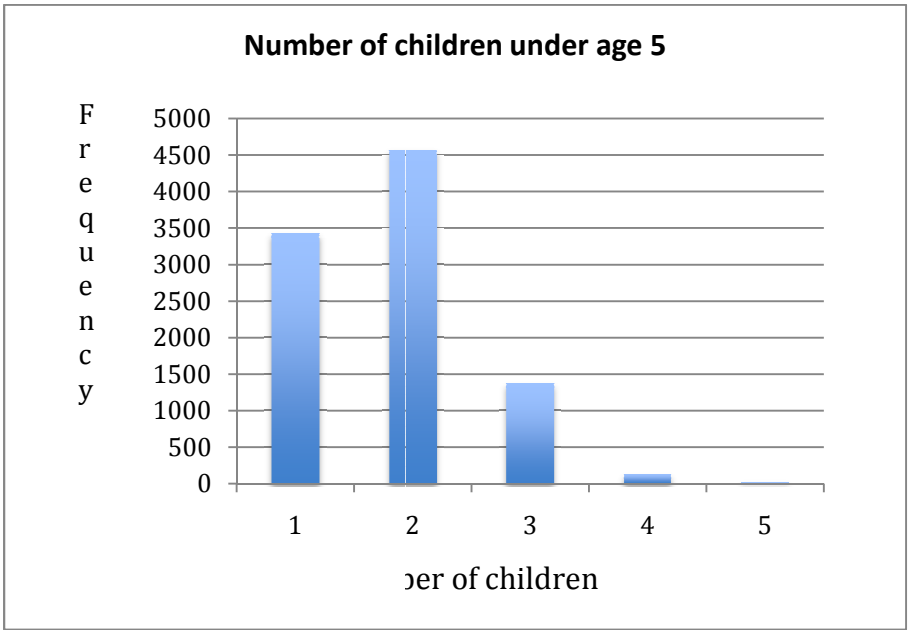

Figure 5. Number of children 5 and under

Figure 5 shows vaccination status in percentage by age of child (1-4). This figure illustrates that the number of children who had completed vaccination was higher for younger cohorts. A higher percentage (22.6%) of children who were in the 1 year-old cohort had completed the EPI (except polio 0 vaccination) recommended immunization during the EDHS survey than any other age cohort. The percentage of children who have not received vaccination is highest for the 4 year-old cohort (34.2%) and this proportion is lower for younger cohorts. Fewer children had not received any vaccination in the 3 year-old cohort (30.1%), 2 year-old cohort (29%)

and 1 year-old cohort (24.7%). However, incomplete vaccination remains a feature for all cohorts, ranging from 50 to 54%. This shows incomplete and delayed immunization is higher than other statuses. In this analysis, children who did not complete their vaccine schedule by the first year after birth are considered partially vaccinated.

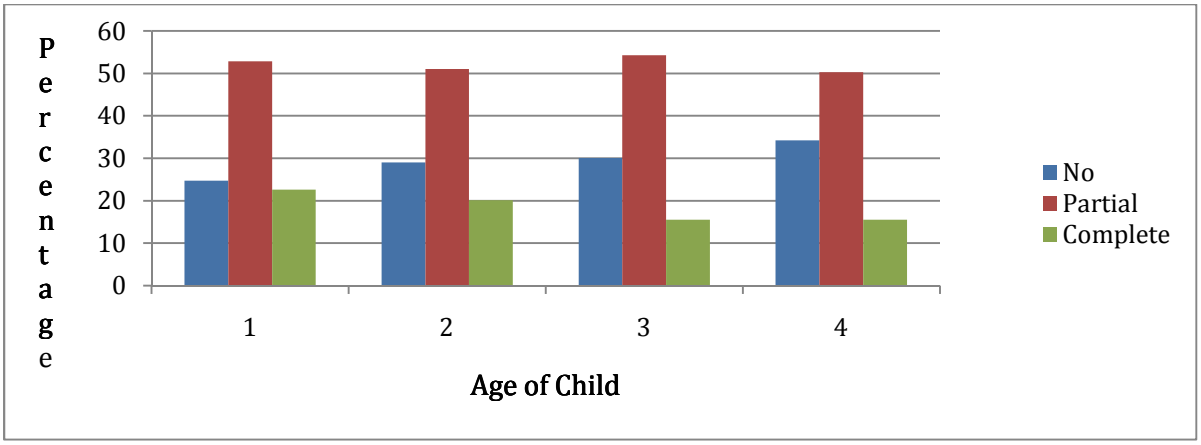

Figure 6. Vaccination Status by Age of Child

4.4 Factors Associated with Incomplete Vaccination

Table 5 explores the same characteristics as Table 2 but looks at distribution by vaccination status of children. Vaccination status is measured according to EPI schedule for routine vaccination. Chi-square analysis was conducted for these characteristics. The analysis showed that children who were first born (19.8%); lived in urban settings (38.6%); lived in Addis Abeba (50.6%);were the highest wealth quintile (31.9%); had both parents with higher than secondary education; had mothers aged between 25-29; and had fathers between the ages of 30-34 had higher rates of complete vaccination.

Table 5. Association of Select Demographic Characteristics of Families and Child's Vaccination Status (N=8905)

	Vaccination Status			
Characteristics	No (%)	Partial (%)	Complete (%)	Total Number
Birth Order	P< .001*			
First Child	515 (30.3)	846(49.9)	336 (19.8)	1697
Second Child	462(30.7)	775(51.6)	266(17.7)	1503
Third Child	423 (32.1)	695(52.7)	200 (15.2)	1318
Fourth Child	397 (35)	568 (50.1)	168 (14.8)	1133
Fifth Child	306 (33.6)	485 (53.3)	119 (13.1)	910
Sixth Child	279 (36.7)	391 (51.4)	90 (11.8)	760
Seventh & Above	512 (32.3)	891 (56.3)	181 (11.4)	1584
Residence	P< .001*			
Rural	2721 (35.6)	4051 (53)	875 (11.4)	7647
Urban	173 (13.8)	600 (47.7)	485 (38.6)	1258
Region	P< .001*			
Tigray	121 (13.6)	484 (54.3)	286 (32.1)	891
Afar	235 (45.5)	275 (53.2)	7 (1.4)	517
Amhara	299 (23.3)	808 (63)	176 (13.7)	1283
Oromiya	628 (35.9)	948 (54.3)	171 (9.8)	1747
Somali	462 (76.9)	136 (22.6)	3 (0.5)	601
Ben-Gumz	246 (39)	318 (50.5)	66 (10.5)	630
SNNP	467 (30)	882 (56.6)	208 (13.4)	1557
Gambela	190 (39.7)	229 (47.9)	59 (12.3)	478
Harari	128 (27.6)	242 (52.2)	94 (20.3)	464
Addis Abeba	26 (7.2)	152 (42.2)	182 (50.6)	360
Dire Dawa	92 (24.4)	177 (46.9)	108 (28.6)	377
Wealth Index	P<.001*			
Poorest	1051 (45.9)	1075 (469)	165 (7.2)	2291
Poorer	613 (37)	847 (51.1)	197 (11.9)	1657
Middle	520 (32.1)	877 (54.1)	225 (13.9)	1622
Richer	415 (27.8)	891 (59.8)	185 (12.4)	1491
Richest	295 (16)	961 (52.1)	588 (31.9)	1844
Mother's Education	P<.001*			
None	2498 (36.6)	3541 (51.9)	784 (11.5)	6823
Primary	345 (24.2)	790 (55.5)	289 (20.3)	1424
Secondary	48 (8.1)	287 (48.6)	255 (43.2)	590
Higher	3 (4.4)	33 (48.5)	32 (47.1)	68

	Vaccination Status			
Characteristics	No (%)	Partial (%)	Complete (%)	Total Number
Father's Education	P<.001*			
None	2024 (38.9)	2607 (50.1)	573 (11)	5204
Primary	651 (28.2)	1296 (56.2)	360 (15.6)	2307
Secondary	187 (16.8)	600 (53.9)	327 (29.4)	1114
Higher	15 (8.1)	94 (50.8)	76 (41.1)	185
Mother's Age	P<.001*			
15-19	197 (42.2)	216 (46.3)	54 (11.6)	467
20-24	592 (31.9)	973 (52.5)	288 (15.5)	1853
25-29	819 (31.4)	1369 (52.5)	420 (16.1)	2608
30-34	592 (33.1)	908 (50.8)	286 (16)	1786
35-39	419 (30.7)	747 (54.8)	198 (14.5)	1364
40-44	213 (36.4)	294 (50.3)	78 (13.3)	585
45-49	62 (25.6)	144 (59.5)	36 (14.9)	242
Father's Age	P=.076*			
15-19	7 (43.8)	8(50)	1 (6.3)	16
20-24	141 (36.8)	202 (52.7)	40 (10.4)	383
25-29	451 (34.2)	684 (51.9)	182 (13.8)	1317
30-34	563 (31.6)	924 (51.9)	295 (16.6)	1782
35-39	548 (32.4)	873 (51.7)	268 (15.9)	1689
40-44	427 (34.1)	662 (52.9)	163 (13.0)	1252
45+	624 (32.8)	983 (51.7)	295 (15.5)	1902

* Chi-square P value.

4.5 Risk Factor Model for Child Vaccination Incompletion

Odds of the selected demographic characteristics playing a role in vaccination status were examined. For further analysis, the dependent variable was dichotomized into "No/Partial" and "Complete" vaccination. Odds of having complete immunization was compared with no or partial immunization. Significant crude odds ratios indicate several characteristics as risk factors for incomplete vaccination. Being third or later born in the family, with significance, contributed to being less likely to be vaccinated. Being from a

rural area was significantly associated with not being fully vaccinated (p<.001). Being from any region other than the capital of Addis Abeba was also associated with not being fully vaccinated. A child from the Somali region was only 0.005 times (95% CI [0.002-0.016] as likely to be fully vaccinated as a child from Addis Abeba. Children from lower wealth quintiles (p<.001) showed significantly lower rates of vaccination completion than the highest quintile. However, there was no pattern of progressive risk increase associated with wealth. Children whose mothers had no education showed .146 times (95% CI[.090-.236]) and children whose mothers had primary education showed .286 times (95%CI [.175-.469]) the likelihood of being fully vaccinated as children whose mothers had higher education. Likelihood of being vaccinated was significantly associated with father's education (p<.05) showing a correlation between higher education and increased likelihood of vaccination. Some age ranges for mothers and fathers were significantly correlated with vaccination completion.

Table 6: Unadjusted Odds Ratio of Vaccination Status and Independent Demographic Characteristics

Characteristics	Vaccination Complete Odds Ratio	P-value
Birth Order		
First Child	1	
Second Child	.871 [.729-1.041]	0.129
Third Child	.725 [.598-.878]	0.001
Fourth Child	.705 [.576-.864]	0.001
Fifth Child	.609 [.486-.764]	<.001
Sixth Child	.544 [.424-.699]	<.001
Seventh & Above	.523 [.430-.635]	<.001
Residence		
Rural	.206 [.180-.235]	<.001
Urban	1	

Characteristics	Vaccination Complete Odds Ratio	P-value
Region		
Tigray	.462 [.360-.594]	<.001
Afar	.013 [.006-.029]	<.001
Amhara	.155 [.120-.202]	<.001
Oromiya	.106 [.082-.138]	<.001
Somali	.005 [.002-.016]	<.001
Ben-Gumz	.114 [.082-.159]	<.001
SNNP	.151[.117-.194]	<.001
Gambela	.138 [.098-.194]	<.001
Harari	.248 [.183-.338]	<.001
Addis Abeba	1	
Dire Dawa	.393 [.290-.532]	<.001
Wealth Index		
Poorest	.166 [.138-.200]	<.001
Poorer	.288 [.241-.344]	<.001
Middle	.344 [.290-.408]	<.001
Richer	.303 [.252-.363]	<.001
Richest	1	
Mother's Education		
None	.146 [.090-.236]	<.001
Primary	.286 [.175-.469]	<.001
Secondary	.856 [.518-1.417]	0.546
Higher	1	
Father's Education		
None	.177 [.131-.241]	<.001
Primary	.265 [.194-.363]	<.001
Secondary	.596 [.433-.821]	0.002
Higher	1	
Mother's Age		
15-19	.681 [.503-.922]	0.013
20-24	.959 [.814-1.129]	0.613
25-29	1	
30-34	.993 [.843-1.170]	0.936
35-39	.885 [.736-1.063]	0.190
40-44	.801 [.618-1.040]	0.096
45-49	.910 [.629-1.317]	0.618

Father's Age		
15-19	.336 [.044-2.554]	0.292
20-24	.588 [.414-.835]	0.003
25-29	.808 [.662-.987]	0.037
30-34	1	
35-39	.951 [.794-1.139]	0.583
40-44	.754 [.614-.928]	0.008
45+	.925 [.776-1.104]	0.388

Logistic modeling with the selected factors was conducted with vaccination status and the demographic characteristics of families as independent factors. Type of Residence, Region and Wealth Index were the only significant characteristics in predicting the likelihood of a child being vaccinated when controlling for other factors. A child from the regional state of Tigray had a higher likelihood (OR: 1.779 [95% CI: 1.265-2.501]) of being vaccinated than a child from the capital, Addis Abeba. However, children from all other regional states and the city state of Dire Dawa had a lower likelihood than Addis Abeba in being fully vaccinated. Urban children had a higher likelihood of being vaccinated than rural children (OR: 0.444CI[0.342-0.576]). Additionally, children from the richest quintile had a higher likelihood of being vaccinated than any other wealth quintile. Other characteristics such as parents' education and age were not significant. Through this exploration of EDHS data, highest likelihood of vaccination completion was for an urban, child from Tigray who is also from the richest quintile of the society. Lowest likelihood of vaccination completion was for a child who happens to be 7th or higher numbered child of the family and is from the poorest rural family in Somali.

Table 7. Adjusted Odds Ratio of Vaccination Completion Risk Factors

Characteristics	Vaccination Completion OR [95%CI]	P-value*
Birth Order		
First Child	1	
Second Child	.841 [.672-1.052]	0.13
Third Child	.813 [.631-1.047]	0.108
Fourth Child	.823 [.624-1.087]	0.171
Fifth Child	.680 [.496-.931]	0.016
Sixth Child	.642 [.456-.904]	0.011
Seventh & Above	.588 [.421-.822]	0.002
Residence		
Rural	.444 [.342-.576]	<.001
Urban	1	
Region		
Tigray	1.779 [1.265-2.501]	0.001
Afar	.058 [.026-.129]	<.001
Amhara	.545 [.387-.767]	<.001
Oromiya	.364 [.260-.510]	<.001
Somali	.020 [.006-.065]	<.001
Ben-Gumz	.378 [.255-.560]	<.001
SNNP	.465 {.334-.647]	<.001
Gambela	.399 [.264-.604]	<.001
Harari	.468 [.325-.673]	<.001
Addis Abeba	1	
Dire Dawa	.674 [.468-.971]	0.034
Wealth Index		
Poorest	.435 [.328-.576]	<.001
Poorer	.592 [.455-.771]	<.001
Middle	.757 [.590-.972]	0.029
Richer	.650 [.507-.835]	0.001
Richest	1	<.001
Mother's Education		
None	.869 [.464-1.624]	0.659
Primary	1.222 [.656-2.277]	0.527
Secondary	1.201 [.669-2.156]	0.54
Higher	1	
Father's Education		
None	1.012 [.651-1.575]	0.957
Primary	1.094 [.710-1.684]	0.685
Secondary	1.267 [.847-1.895]	0.249
Higher	1	

Characteristics	Vaccination Completion OR [95%CI]	P-value*
Mother's Age		
15-19	.786 [.523-1.181]	0.246
20-24	.875 [.706-1.086]	0.225
25-29	1	
30-34	1.063 [.856-1.319]	0.581
35-39	1.209 [.912-1.601]	0.187
40-44	1.055 [.715-1.555]	0.787
45-49	1.393 [.843-2.301]	0.195
Father's Age		
15-19	.480 [.058-3.946]	0.494
20-24	.655 [.432-.994]	0.047
25-29	.858 [.680-1.083]	0.197
30-34	1	
35-39	1.028 [.835-1.267]	0.793
40-44	.919 [.708-1.194]	0.529
45+	1.225 [.940-1.596]	0.132

*Measured significance between those with no or partial vaccination &complete vaccination

CHAPTER 5: DISCUSSION

In addition to malnutrition, the major cause of childhood mortality in Ethiopia is vaccine preventable diseases. Childhood mortality can be significantly lowered if routine vaccination is completed. There are several community level localized studies exploring child vaccination coverage in Ethiopia. However, many of these do not look at aggregate country level data to make assessments on vaccination coverage and disparities across the country. Countries strive to equalize health outcomes among all people. The goal is to have health outcomes not be dependent on social, economic or geographic factors. When there is a non-physiological risk factor for a health outcome, disparities are uncovered. The objective of this study was to identify family factors that might contribute to child vaccination defaulting in Ethiopia. Family factors were examined to uncover family behavior that are shaped by culture and institutions and also shaped by issues of access to development components such as education and roads. The second objective of the study was to explore the depth of disparities between those with high vaccination and those with low vaccination rate. The third objective of this study was to find out whether the rates of no vaccination was similar or different from incomplete vaccination. The third objective was helpful in providing a clear picture as to which dimension of RI immunization was a bigger issue in Ethiopia.

5.1 Wealth & Geography

This analysis of a subsample of the 2005 Ethiopia DHS data shows that wealth and vaccination coverage is highly associated (Table 7). Wealth distribution among regions gives some indication of material wealth of the families in the sample. However, the sheer diversity of the people in the country can be masked without a thorough analysis of all social determinants of health outcome. Pastorals have a very different lifestyle than urban dwellers. Additionally, since the wealth index uses measures of development such as sanitation and type of flooring, urban families may always be perceived as being in higher socio-economic status (SES) than rural families. Therefore, geographic and cultural context must be taken into consideration when examining the variable of wealth index. Hardships experienced by poor in urban settings and rural settings will be different. The wealth index variable can be used to examine vaccination seeking behavior of parents when examined in tandem with geographical variables such as urban/rural residence and region. As Kidane et al, had uncovered those with longer than one hour walk from an immunization site had lower vaccination rates (2006). There are fewer health facilities in rural settings than urban settings necessitating longer commutes for families. This travel for vaccination has a cost in terms of time and money. Due to geographic disparities the cost is higher for lower income families from rural settings than other groups. The results showed that the children from Afar and Somali had low odds of being vaccinated. This region also contains those in the poorest wealth index segment of the population and due to topography, the regions may be not be easily navigable. Also both regions have large nomadic communities who may reside far from health facilities. Their lower likelihood

of vaccination shows that the cost of vaccines in terms of time and other factors may compel them to forgo child vaccination.

5.2 Epidemiology of Vaccines

More children in Ethiopia start and do not complete all EPI recommended RI vaccines (Figure 5) than those who complete their vaccine schedule. This group of defaulter is bigger than the group that has no vaccines. However, both the children that have no vaccines and those that have partial vaccination are in similar risk of acquiring vaccine preventable diseases. Any attempts to improve vaccination delivery and efficacy must take into account the default rates in Ethiopia. Before introducing new vaccines that are used in more developed countries or adding other recommendations to the EPI schedule, the risk from incompletion has to be measured against no vaccination. Additionally, SIA activity to improve immunity, targeted at children who have high default rates in Ethiopia can reduce their risk.

5.3 Parity & Birth Order

Parity of mothers in the last five years is captured in this data. Parity affects child's likelihood of being vaccinated and morbidity when family resources including time and attention are shared among several children. Urban households in the capital of Addis Abeba have a fertility rate of 1.4 per woman, have lower child mortality than any other region (EDHS, 2005). As the analysis shows (Figure 4), 48% of the mothers had two children under the age of five at the time of the survey. However, about 1% of the mothers had 4 children within the last five years. Some studies have found parity affects child health outcome (Vandermeulen, et al., 2008; Reading, et al., 2004) and others did not (Tadessa et al, 2008). However, in this analysis, looking at this variable

in the context of birth order gives some idea of trends. Being fifth or above in the family showed strong association with vaccination incompletion (Table 7). In many countries, health programs shaped around birth spacing have been successful in raising health outcomes of both maternal and child health. Emphasis on birth spacing can have an impact on vaccination demand and vaccination seeking behavior among parents.

5.4 Political and Economical Factors

Figure 7 illustrates a proposed model of influences on immunization. Parents' and caretakers' behavior around child vaccination is a microcosm of various social determinants affecting their decision-making. International policy, national economics and family decisions all play roles in childhood vaccination. This study only examined a few factors in the core of this model.

Childhood immunization and eventual elimination of many of the vaccine preventable diseases is a global agenda. The success with small pox has shown the world that such a goal is achievable. Support from international funders such as UNICEF, GAVI, WHO and bilateral support is available to Ethiopia. However, many logistical hurdles affect vaccine efficacy and play a role in family's behavior around childhood vaccination. Geopolitical issues affect Ethiopia's success with vaccination. The Somali

Figure 7: Levels of Influence on Childhood Vaccination

region in Ethiopia has very low child immunization completion levels (Table 5). This region consists of nomadic groups and Ministry of Health efforts have not found a viable way to reach this population. Vaccination levels are very low in Ethiopia's neighbor, Somalia (Figure 2). Given the political issues of neighboring Somalia and the porous borders between the two countries, the risk to those in the Somali region maybe increased due to geopolitics.

A systematic review of interventions aimed at increasing demand for vaccine such as vaccination campaigns, and community education, found that these vaccination promotion interventions had an average cost of $10-$20 per child (Shea, et al., 2009). Some factors affecting childhood vaccination in Ethiopia, such as better systems of cold chain storage are being addressed by the Ethiopian health ministry, WHO, GAVI and other partners. Others require resources further removed from health such as better roads and education. High odds of vaccination completion among the wealthy and urban families (Table 7) shows that these groups have resources that allows them to overcome hurdles and access child immunization. However, immunization is a population level service and should be accessible to the entire population. For many years, national resources have been used in civil and cross border conflict. Ethiopia's efforts around issues of development will also show results in immunization completion and child survival. With development of more healthcare facilities, better storage of vaccination, improved road and basic education, a natural demand may be experienced and fewer resources may be needed directly in vaccination promotion.

5.5 Culture

The population among which vaccination differentials exist have very different culture. Literature review has uncovered that there is a great diversity in culture in Ethiopia, encompassing varied religions, beliefs, food and geography such as the elevation at which the different groups live. This analysis does not examine culture, except in terms of region and type of location. Table 7 reveals large disparities in vaccination coverage. Some issues of access are revealed by literature and this analysis, but correlations among cultural factors require more direct studies. Culturally appropriate vaccination promotion interventions are important to increasing uptake of childhood immunization in Ethiopia. One such practice has been developed by the Ethiopian Orthodox Church. During baptism, the child's vaccination status is questioned and the caretaker is encouraged to complete vaccination (WHO:Expanded program on immunization). Similarly, the *Coffee Ceremony*, a setting where the community discusses pressing issues has been used for vaccine promotion and other behavior change efforts (D. Ward, Personal Communication, July 15, 2009).

5.6 Policy Recommendations

Childhood morbidity from vaccine preventable diseases hinders parents and caretakers ability to actively participate in the economy and reduces contributions children might make to the economy and society in the future. National strategies for poverty alleviation in Ethiopia needs to take into consideration prevention health services such as childhood vaccination. Given the fact that vaccination incompletion is very high among the poorest rural segment of the population, meeting the child vaccination needs of this population should be the first priority. EPI subsidies and

international partnerships have created an interconnected funding system where childhood vaccination can be provided to every child without cost to families. For instance, immunization at food aid and emergency feeding centers can increase use of available infrastructural and logistical resources. Good governance and leadership that can take advantage of the international resources to shape a system that meets the needs of Ethiopia is necessary.

While this is a very limited study, the role of geography in childhood vaccination is clearly demonstrated. More than no vaccination, incomplete vaccination ails children in Ethiopia. Reaching isolated kebeles consistently will allow children to finish their RI schedule. Strategies for how to reach these kebeles during both dry and wet seasons needs to be part of the plans. Additionally, engaging pastoralists in a way that mobilizes them to seek vaccination for their children is also necessary. Increasing coverage of health institutions through both increasing the number of health posts as well as including outreach workers can increase RI.

5.7 Limitations and Suggestions for Future Research

It is hoped that the trends uncovered in this analysis furthers the understanding of issues of vaccination coverage in Ethiopia.

Taking into consideration the fallacies that may occur from this type of analysis, more research on sub-groups is needed. However, childhood immunization is a population level service and low coverage in some regional states compared to others necessitates action. From this analysis, the states that need a vaccination promotion intervention

are Afar and Somali. Further analysis on the health seeking behavior of the parents and caregivers in this region can illuminate best methods of immunization promotion.

This study looked at family characteristics that might affect the decision to complete vaccination in Ethiopia. Studies that look at the effect of international and national policies on childhood vaccination can further illuminate how family decisions are affected by issues of access and vaccine efficacy. A policy evaluation study is recommended to examine issues of vaccination coverage in Ethiopia.

Additionally, as cultural factors were not studied during this analysis, a more in depth look at various practices of parenting might illuminate better ways of influencing behavior change. In many cultures grandmothers are more influential in child's health than the mother. Understanding dynamics of families in the various regions of Ethiopia will allow tailoring of efforts.

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